DOCUMENT RESUME

ED 199 045 SE 034 148

AUTHOR Rasmussen, Lore
TITLE From "My Ball" to "Sphere" or Taking the Time to Think About and Explore with Children Some Thing Over a Long Time and in Unexpected Ways.
INSTITUTION Philadelphia School District, Pa.
PUB DATE 72
NOTE 30p.; For related documents, see SE 034 146-147 and ED 038 275-276. Not available in hard copy due to marginal legibility of original document.
AVAILABLE FROM Learning Centers Project, Durham School, 16th and Lombard Sts., Philadelphia, PA 19146 ($1.00).

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Discovery Learning; Elementary Education; *Elementary School Mathematics; Experiential Learning; *Experiments; *Instructional Materials; Learning Activities; Mathematical Concepts; *Mathematics Instruction; Problem Solving; Resource Materials; Solid Geometry; *Teaching Methods
IDENTIFIERS *Spheres (Geometry)

ABSTRACT

Presented are ways to teach pupils the concept of "sphere" with a methodology far removed from memorization of a formal definition of the concept. The material illustrates an approach to teaching that focuses on open exploration of ideas with children. Many experiments and starting points for exploration are suggested. This document has an appendix of examples of children's research and discoveries related to balls and spheres. (MP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

From "my ball" to "sphere"

U S DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

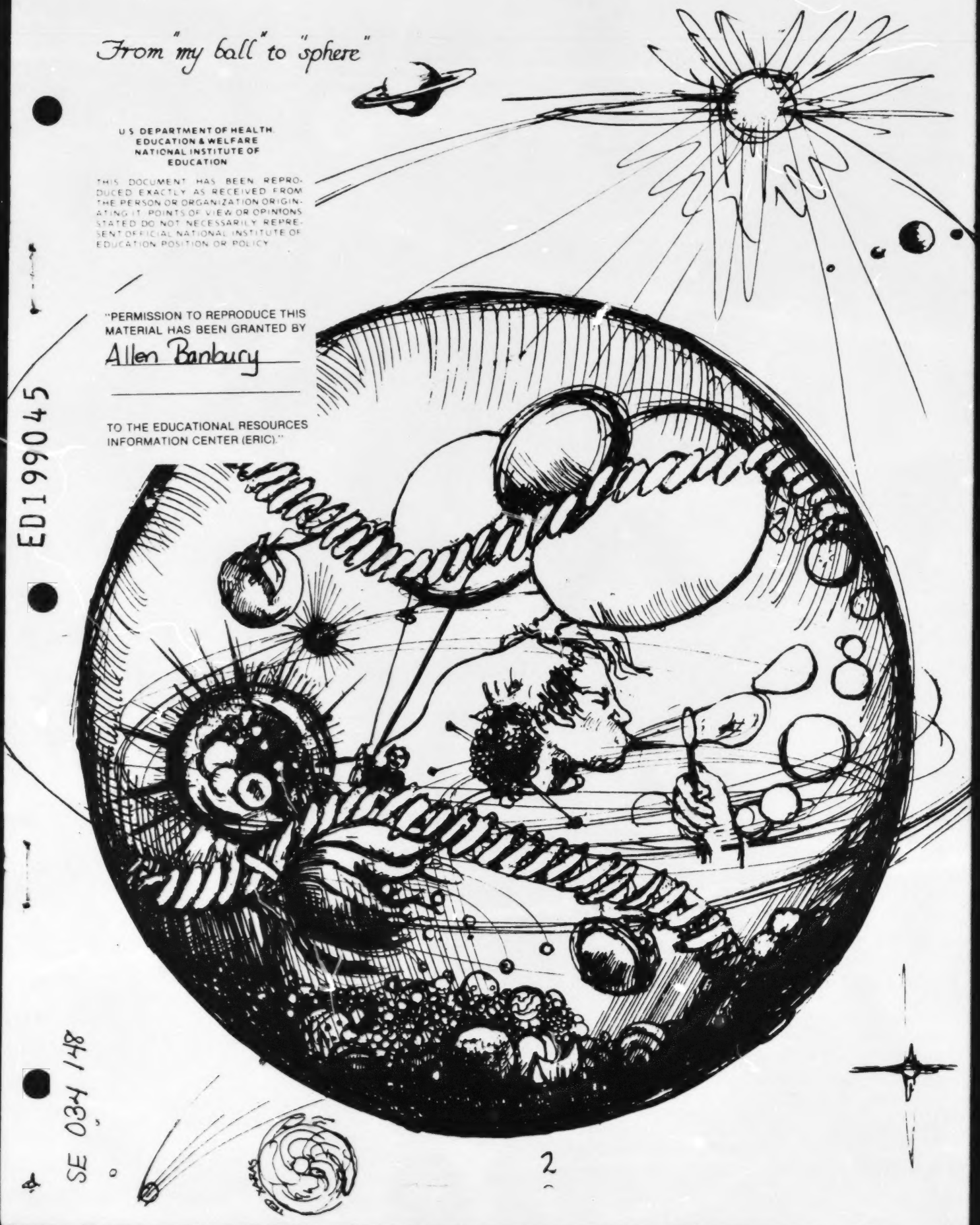
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Allen Banbury

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

ED199045



SE 034 148

Non-profit organizations such as schools, universities, and state departments of instruction may reproduce the complete booklet for their own use provided each copy credits the authors and reproduces the statement boxed below.

This publication, based on a series of articles published in Instructor, February--June, 1965, is one in a series entitled "Teacher to Teacher", written by the staff of the Learning Centers Project, School District of Philadelphia Title I program. Partial support for editing and reproduction provided by a grant from the Ford Foundation.

© 1972, Learning Centers Project, School District of Philadelphia

FROM "MY BALL" TO "SPHERE"

or

Taking the Time to Think About and Explore with Children

Some Thing

Over a Long Time and in Unexpected Ways

Lore Rasmussen, Director
Learning Centers Project
School District of Philadelphia

1.

CONCEPTUALIZING:

FROM "MY BALL" TO "SPHERE"

From working with hundreds of children I have learned what a rich stimulus balls are for teaching certain basic concepts. Children are drawn like magnets to balls. From infancy on, children watch balls roll and bounce. They catch and throw them with success and delight. The whole world understands that balls are theirs to own, to handle, and to play with. A ball is the universal toy of childhood.

"Ball" is even more universal than that. Its spherical shape is possibly the basic geometric form of life. In The Ambidextrous Universe (Basic Books), Martin Gardner wrote, "Primitive one-celled life, floating in a sea and constantly tumbling about, would naturally assume a spherical form with planes of symmetry in all directions. But once a living form anchors itself to the bottom of a sea or to the land, a permanent up-down axis is created."* Aren't planets and stars, as well as egg yolks and seeds of peppers, poppies, and avocados approximate spheres? What about the fragile and elusive soap bubble?

The magic attractiveness of balls to children can be harnessed to isolate in a creative way their similarity as geometric solids. At first the children's strong

* Martin Gardner, The Ambidextrous Universe, Basic Books, New York, 1964, p.52.

emotional attachments to specific "fun balls" with their individual names will carefully hide from them their common characteristics as spheres. The road from "my ball" to "sphere" is a long one. It is almost as long as the one traveled from "me," "mom," "my family," and "my friends" to the concept, "human being."

Have you ever touched, seen, smelled, or heard "gravity," "number," or "harmony?" Of course not, for these are concepts - abstractions slowly formed from parts of many specific experiences and events. Their composite impact eventually provides our minds with data by which we can group common elements. Such concepts as tool, liquid, energy, time, number, plant, triangle, mercy, and enemy have no meaning unless we know from experience a variety of examples which, when stripped of their differences, reveal a common core.

Concepts are man's attempt to simplify the chaos of impressions that bombard him daily, so he can cope with the physical world and human relationships. Some concepts are formed unaided in early childhood; others are forever being formed, revised, or discarded. Some are known only to specialists or are yet for other generations to discover.

Schools can aid in concept formation by providing multitudes of experiences through which children learn to observe, ponder, analyze, and abstract. Through

concepts, facts are related and given hierarchies of importance. Concepts also give birth to inventions.

I hope to illustrate how a teacher might proceed to help children to form the concept of "sphere" from its beginnings as "my ball". With slight variation the methodology is applicable to the formation of most concepts you choose to develop.

How might one proceed in the classroom to explore this road? Why not just say, "Balls are representations of spheres. A sphere is a surface generated by revolving a semicircle about a diameter. The center of the sphere is the center of the generating semicircle. The radius of the sphere is a line segment from the center to any point on the sphere. All points on the sphere are thus equidistant from one fixed point, the center. This is all there is to it. Learn it."

Memorizing these words or others like them is not knowing the concept. It is not insight arising from personal observation and manipulation of specific phenomena in the environment and linking them to one another, sifting their meanings, removing distractions and irrelevant data in order to extract communality.

Begin instead by deliberately evoking the experience

of a whirlwind of balls, a symphony, a dance of balls -- balls bouncing, flying, rolling, floating, falling; balls red, blue, transparent; small balls, huge balls; light balls, heavy balls; balls bursting, melting, long-lived; noisy and silent; soft and hard; cork balls, lead balls, rubber balls, snowballs; marbles, bubbles, pellets-- different, so different all, but clearly, unmistakably BALLS. Why are they all balls? What <u>are</u> balls?

When we ask the child about balls in his experience, we quickly get a long list. A young child names them first by color and size. An older child describes them by the game they are used in or by their composition. They are only too glad to start collecting for the classroom. After the usual wide array of toy balls and game balls has found its way to school, the household and school yield candy, sugar, pepper kernels, hard-boiled egg yolks, mothballs, a corkfloater, a globe.

Recess becomes ball time, soap bubble time, balloon time. During science class different ball materials and their properties are explored. Tanks of water separate the balls into sinkers and floaters. Language time is spent playing games such as finding a ball in the collection by its verbal description, or creating longer and longer strings of appropriate adjectives for a particular ball.

A few empty sorting boxes encourage many private ways of classifying balls by principles which others must guess.

How much time is spent on any one activity depends on the age, maturity, and cultural background of the child. For six-year olds with meager color and size vocabularies, it is important to talk about Cheryl's medium-sized dark green ball and Joe's small, orange shiny ball. Eight-year olds are challenged by ordering a diverse assortment of balls by volume and inventing several workable ways of referring uniquely to them by their place. Older children's extensive collections of game balls might lead to new hobbies, the study of game rules, or the invention of new ball games. Collecting balls by their composition (only one of a kind allowed) might lead to an investigation of how they behave, materials, their life spans, their synthetic or organic origin, the effect of cold or heat or pressure on them. Many questions such as "Why are croquet balls wooden and ping-pong balls hollow plastic?" will be raised and answered.

All this play, description, and experimentation should have made the point that, while there is a vast variety among balls, there is no difficulty differentiating a "ball" from a "not ball." It should have become clear that a common geometry, a similar shape, is the

unifying concept. All balls are representations of spheres.

Some are excellent models, like the soap bubble. Others like the "pimple" ball, are less good. The need then arises to define more clearly what is meant by "ball" and to make the definition broad enough to permit such objects as marbles, soap bubbles, and stars among the more obvious ball-like objects. Through examining the characteristics of a great variety of candidates for membership in the family of "balls", it becomes established that criteria such as size, composition and function do not determine inclusion or exclusion in the family, as interesting as these attributes are.

Thus we are building consciously in the mind of the child a new, workable sieve through whose mesh fall the myriad of nonspherical things and which retains the gaseous mass of the sun alongside the ping-pong ball and the poppy seed.

MOVING BEYOND SPONTANEOUS CONCEPTS

You may say that this sifting into balls and nonballs will occur and does occur in every individual child unaided by the school. Is it not true that when seeing a large collection of different objects, any child of even

preschool age will instantly pick out the balls upon request? Or that this same small child will find by feel from a grab bag, sight unseen, all the spherical objects? Hence, he must "know" by sight and touch what spheres are.

These correct, nonverbal responses to concrete situations are, however, pre-intellectual. We have only to ask these same children, "What is a ball?" and they are in trouble. They might answer, "A ball is a ball," or "This red ball is a ball," or "A ball is round." It will require a considerable period of time before the correct sorting responses to sensory materials are matched by the verbal ability to express the rationale of these same actions.

Visual and tactile sorting of balls and nonballs is an example of a primitive, spontaneously formed concept, while the higher organization and abstraction of the properties of spheres into precise language is a scientific concept. This follows the development of concept formation as outlined by Vygotsky in Thought and Language. It is his thesis that the formation of scientific concepts can be aided by school instruction, when this instruction is sensitive to the stages of a child's natural spontaneous concept development. Both Vygotsky and Piaget in their researches come to the conclusion that "A child becomes aware of differences earlier than of likenesses because awareness

of similarity requires a more advanced structure of generalization and conceptualization than awareness of dis-similarity."

Let us consider examples of classroom episodes where children spontaneously signal some beginning generalization about common properties of spheres. Notice how a creative teacher can utilize these in her teaching.

A six-year-old accidentally spills beads on the floor and discovers that he can use the beads as rollers to transport heavy boards and cartons in all directions without exerting himself to lift or drag. He and his friends try the same thing with balls of another size, and it works. The perceptive teacher can encourage these children to try nonball rollers, blocks, cylinders, or stones to see if any of those objects work as well as balls.

Another child during clean-up time puts all balls in a basket because "balls" are very unsteady. They don't stay in one place. They don't touch the ground much and always roll away. They don't have a flat bottom. This may be followed in another playtime with the pupils and teacher looking for other unsteady things.

The grab-bag-feeling game, when played by nine-year-olds, brought the following verbatim commentary by

a child: "When I feel the other blocks, I feel flat faces, sharp edges, and points. My fingers have to go over an edge to go from one face to another face. They have to go over a point before going from one edge to another edge. On a ball my fingers go evenly over the whole outside. The feel is always curved smoothly. Is that outside called a face when it doesn't have any edges around it?" As a result of this, the children reexamined all the solids in their bags. The class then attempted to describe and define the surfaces of a variety of solids.

A fourth-grade class is busy making models of regular geometric solids. They invent or find in reference books flat patterns which they draw, cut, and fold into solids. This is successful for the cylinder, cone, cube, and many more figures. But it cannot be done for the sphere. The children can roll them out of clay or wax, but much discussion goes on as they work. They are dissatisfied with the accuracy of their results. One child with a flash of insight interrupts them, pulls some bubble gum out of his pocket, blows a huge gum bubble, and proudly parades around. He made a better model -- more exactly achieved -- than all the rest.

With the teacher's encouragement the children may search for and experiment with several methods of sphere-making and write them up as sphere recipes. They may

have roll recipes, dip recipes, mold recipes, and blow recipes. Their conclusion may be that blow recipes give the best results in the easiest way -- though they are not permanent.

Children may marvel at the beautiful spheres they produce with the soap-bubble method and decide that they can think of no other regular shape which they can produce so effortlessly and in such perfection. They begin to wonder why.

EXPLORING A CONCEPT

Now let's consider experiments and games through which older children can gain insight into the special properties of the spherical surface, into the symmetry of the sphere, into cuts of the sphere, and other interesting characteristics. These investigations will be more structured and analytical as the special features of the sphere are highlighted by comparisons with other regular solids. The following definition might refresh your memory of geometry: "A sphere is a special kind of surface in three dimensions, all points of which are at a given distance from some particular point. The particular point is the center of of the sphere, and the given distance is the radius of the sphere."

Rather than having pupils repeat this definition and illustrate it with a few chalkboard diagrams, we prefer

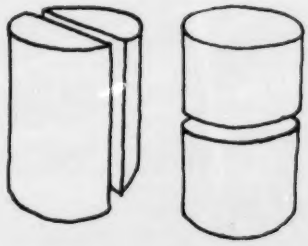
the longer road of having the children dissect some spheres to find the properties for themselves. They will discover properties mentioned in the definition and many less commonly taught ideas about spheres. We would also dissect other solid forms so that children might contrast, compare, and actually see the unique features of the sphere chiseled in clear relief.

In an upper-elementary classroom each child has many clay objects, including a free form, an animal, several small cones, cubes, cylinders, and spheres. The children made these objects the day before and allowed them to harden enough to be cut easily with cheese cutters or pieces of wire.

The problem is to cut each object by one straight cut into two approximately mirrored halves. Can this be done to all objects? Those objects that could not be halved are put aside; they are asymmetric.

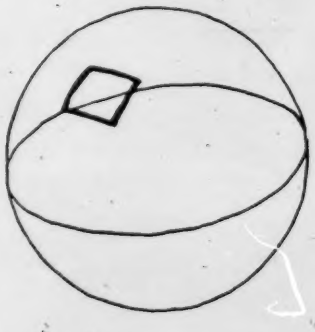
The others are examined more closely to see in how many ways they could be halved. The animals (dog, man, or bug) could be cut in only one way. The same would be true for a coffee cup or chair. Such figures have bilateral symmetry, a left and right part with one plane of symmetry (the cut).

How many more ways are there to halve the cone, cylinder, cube, and sphere? We find nine different cuts for the cube and an infinite number for the cone, cylinder, and sphere. But even among these solids there are differences. The cone can be cut in an infinite number of places only through its axis and not at all in another direction.



The cylinder has an infinity of planes of symmetry through its axis and only one plane of symmetry which cuts the center of the axis at right angles.

The sphere has an infinite number of planes of symmetry. Any cut through its center will halve it. Hence, the sphere has perfect symmetry.



When we take another look at our objects, we find that objects with bilateral symmetry have clearly marked fronts and backs, clearly distinguishable tops and bottoms, but barely different rights and lefts. When we examine the cone with its infinite number of vertical symmetry planes, it might suggest the symmetry of trees or most flowers, with marked tops and bottoms, but no left-right, front-back differentiation. Fruits like grapes and watermelons are very similar in their symmetry to the cylinder.

Cutting a half-sphere, or hemisphere, we see that the cut made is shaped like a circle. We mark the center of the circle, then press some toothpicks like spokes of a wheel from the boundary of the circle to the center. Also stick some toothpicks from other parts of the outer surface of the hemisphere to the center. How do the lengths of the protruding toothpicks compare with one another? Although our models are crude, could we make a conjecture as to how distances from the center to any points on the surface of the sphere compare?

There are many other ways children can make models which show how equal-length line segments going in all directions from a single point describe a sphere. Any knitter who had made a pompom for the top of a cap knows one technique which fascinates children. At this point I would wish for a slow-motion film of a dandelion seed-pod

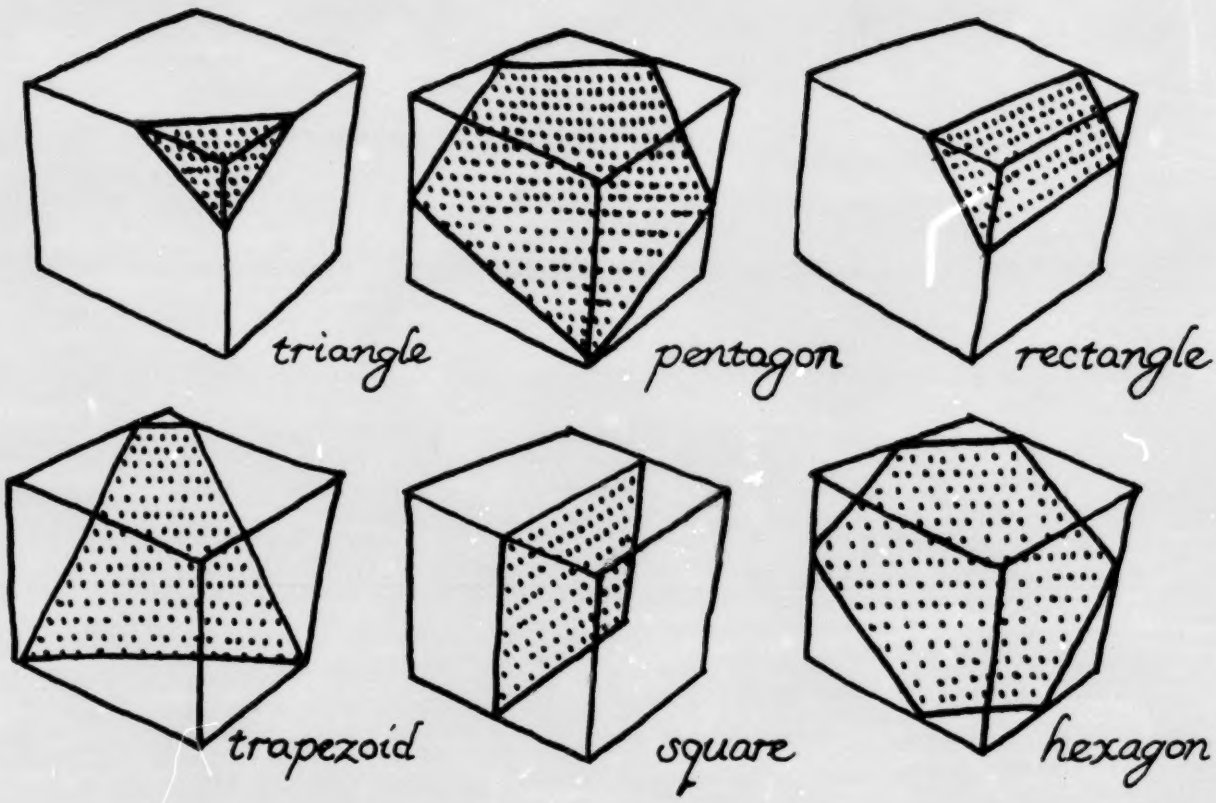
opening up until it has become a spherical wonder for children to behold!

Our clay models of the cone, cylinder, cube, and sphere can be used for other cutting experiments. We already made circular cuts through the center of the sphere to make hemispheres. Straight cuts through <u>any part</u> of a sphere, as long as we get two pieces are circular! Try as we may, we can make only circular cuts. The only thing to differentiate among the cuts is the size of the circle we get.

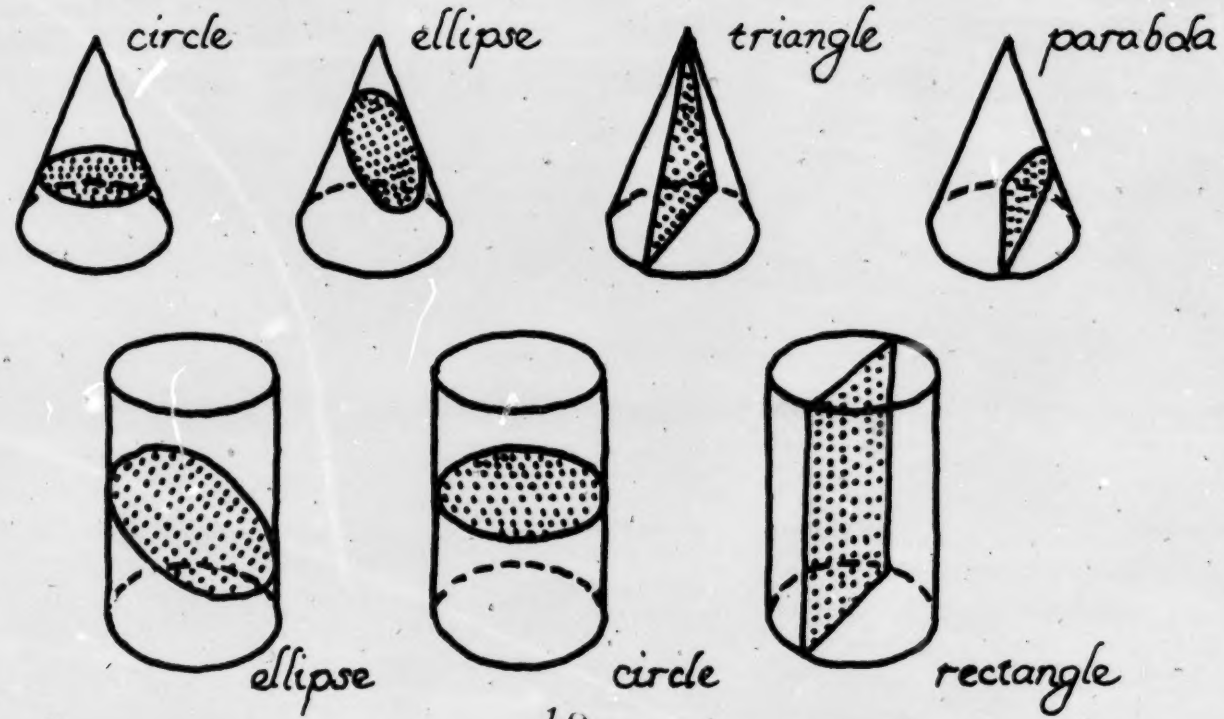
Center cuts make the largest circles, the <u>great circles</u>. Although we can trace many parallel circles on the surface of a sphere, only one of them will be a great circle. <u>Great circles are never parallel to one another; they always intersect one another</u>.

Are all cuts that divide cubes into two pieces square cuts? Try. Maybe the children will find by themselves all the following cut shapes:

(See illustrations on next page)



And what are some of the cuts for a cone and a cylinder?



We have not even exhausted all the cuts we could get for the above solids. But we have gone far enough in exploring the concept to be impressed by the uniqueness of the sphere, which can only produce circle cuts.

Although your first teaching objective is to help the child conceptualize sphere from his many experiences with various and particular balls, you have yet an ultimate aim -- to use the concept, not as an end, but as a tool and a means to exploring more of reality. You can do this through observing still other properties of the sphere such as its packing qualities and also by studying spherical formations in nature. As an exciting, effective teacher, you are yourself an active observer. You will wonder at the conglomeration of spherical bubbles produced by water run rapidly into a sink. You will thrill to the beauty of foam in soapy water or a beaten egg white.

The phenomenon of sphere formation can be seen in the spectacle of bread making, where each well-formed, barely touching spherical unit of dough rises and expands to take up all possible contact points among the others. Each becomes flattened where surrounded, yet maintains its curvature where free. Photo enlargements of the cell structures of many of our own solid organs, such as the liver, reveal the same process as in bread-making. Thus

we begin to see that many single-celled animals are spherical, as is the single egg cell, and that many larger organs are basically packings of spherical cells.

There are the slow-motion close-ups of spherical raindrops, or the web of 120,000 spherical beads made by a garden spider. Observe also the stars and their planets, the planets and their moons, the pearl of the oyster and the honeycomb of the bee.

It is not surprising that children possess a sense of wonder as they respond to the inner structural beauty of nature. They are elated when a teacher lets them mess with soap bubbles, doughballs, or with oil, water, and soap mixtures, then tells them to blow, shake, and stir -- or just watch and watch to see what happens. The wonder of it is that something always happens and changes so fast.

Our universe is in constant, restless motion. It is violent in its bursting, sinking, rising, reforming, disappearing -- but not without reason or controls. In spite of the turmoil, the growth and death, there is form and structure. How can we learn what that form and structure is? To discover that, we must observe over and over again.

Children's drawings can approximate the things they see. Or models can be made -- rigid ones of marbles

closely packed, flexible ones of clay compressed to show effects of pressure, or expandable ones of yeast dough to show cell growth in spherical packs.

If we take marbles and put them together with glue, how do they fit? Three marbles stay put as a triangle. Four will not stay as a square, but will stay in an elongated diamond. Lines from the center of each marble to the centers of those closest produce 60-degree angles, not 90-degree ones. Nature prefers to build in 60-degree angles.

To surround a marble with other marbles in one plane, we can do it exactly with six marbles in a hexagonal arrangement. To surround the center marble with twelve more marbles in space, we get the hexagonal layer with triangular layers on the top and bottom. Other formations such as these not only teach science and mathematics, but are beautiful ornaments in themselves.

The above experiments lead us to observe that <u>spheres cannot fill space</u>; there are crevices and noncontact areas. As a side activity, you might explore what regular shapes can be packed to fill space.

Now replicate the structures above with deformable Plasticine or clay balls, then put equal weight and pressure on them. Wax paper and a brick work well on

one layer, but it is trickier for the three-dimensional structures. Whatever method is chosen, the result still demonstrates the basic tendency for all neighboring spheres to flatten under equal pressure at equal rates. Thus crevices are filled by approximately hexagonal cells, joined to one another by straight edges at 120-degree angles. (Herein lies the secret of worker bees making a honeycomb!)

Any child who has watched his mother make cloverleaf rolls knows how three spheres of dough rise and change form in the muffin tin. They retain three spherically curved surfaces on top, develop flat faces where they join, and assume uninterrupted circular walls where their expansion is inhibited by the tin. Watching dough rise is a very good way to observe how spherical cells or bubble masses act and grow, as they adapt to each other in groups and under interference of surrounding surfaces.

There are so many other aspects of the sphere to explore, if we believe in relating them to the world around us. Certainly we are straying far from pure geometry! But then, why should we rigidly departmentalize learning, when a concept intercepts several areas and has now become a tool, a system of ideas which the more mature and sophisticated child can apply to many areas of the curriculum. His concept of "sphere" and his ability to

measure, dissect, arrange, and construct spherical forms can aid him in his study of mathematics, art, architecture, physics, biology, astronomy, and geography, to name only a few areas.

Let us examine the relevance of "sphere" to geography, the study of our life on a sphere. Geometry (earth measure) and geography (earth study) are usually far apart in the school curriculum, but they should not be. After playing with model balls, children become familiar with many geometric notions used in geography. Let us describe some of them.

- North and south poles are simply one pair of the many pairs of poles which a sphere may have. Any straight line going from the outside of a sphere through the center may be an axis of rotation. The intersections of the straight line and the sphere surfaces are called poles. The north and south poles of our planet are the particular points about which it rotates.
- Meridians are some of the great circles that can be constructed over the curving surface of the earth through the poles. Their planes cut the center of the earth and intersect one another at the poles.
- The equator is the great circle which lies on the plane which goes through the center and is perpendicular to the meridians.
- Parallels are the circles running parallel to the equator and perpendicular to the meridians. None except the equator is a great circle.

The network of meridians and parallels is the earth coordinate system, by which we can describe and locate uniquely any point on the surface of the earth.

Hemispheres are all the possible half-earth surfaces. Any straight cut through the center of a sphere divides the sphere into two hemispheres. We consider most commonly only the eastern, western, northern and southern hemispheres.

The above are only a few ways our concepts of spherical objects can be applied to geography. As we watch a child using this concept in other areas, we know that not only has the concept matured, but so has the child's thought process.

I have gone to great length and detail to develop the concept of sphere. My aim has not been to present an in-depth global study, but to illustrate in the most concrete way a step-by-step means of teaching and enlarging upon a single concept in the manner recommended by Jerome Bruner. We might have discussed principles, philosophy, and methods disassociated from any specific concept. I believe, however, that you can best extract the method by your own direct involvement in the process and application.

Now it is up to us as teachers to probe other concepts and their development so that we can help children to grow in other areas as well. For example, how did we ever accomplish the astonishing feat of unifying such unlikely brethren as elephants and protozoa under the

concept, animal? What were the many experiences and reflections from the initial perception of a first specific animal sample, dog or cat, to a mature concept of a set of living organisms? Surely we saw, touched, thought, and read about the no-legged, the two-, four-, six-, or more-legged; the fur-covered, feather-, hair-, scale-, and shell-covered animals. In a beginning way we can justify why all these and many other variations are held together by a concept animalness, which sets them apart as a group from the plant and the inorganic worlds.

This process is one of the miracles of the human mind. Concept development is a long and wondersome road. For none of us has it ended.

It is our first job as teachers to provide our children with rich experiences, and freedom to probe, theorize, and test in all areas of life, so that they grow up not only as well-informed but as life-giving, life-protecting members of the human race. When we discover how to further the maturation of the concepts of peaceful living, neighborliness, and conservation along with science, we will have made our contribution to a better world.

APPENDIX

Examples of Children's "Research" on balls.

(a) What I found out about my ping-pong ball.

It is white, hard, smooth, light-weight, hollow, noisy, odorless. It has a thin plastic skin which gives off a strong odor when it burns with a big flame to a little bit of dry ashes. It floats high on water. It is a good and long bouncer and rolls easily. It will fit into a baby food can but not into a paper towel tube. When I hold it to a light, I can see a seam around its middle. That shows that it was made in two parts.

(b) Balls that I made melt

snowballs
ice balls
wax balls

Balls that I made collapse

beach balls
balloons
basket balls
soap bubbles

Balls that I made dissolve in water

candy sugar balls

Balls that turn into gas

moth balls

Balls that stay liquid
mercury balls

(c) What I found out about balls when I took a bath.

I had a big beach ball, a marble, a clear plastic solid ball, a ping-pong ball and a solid rubber ball and a whiffle ball.

The solid plastic ball and the marble sank fast. I could hear the sound when they dropped to the bottom. They made different sounds. The solid rubber ball also sank but it barely touched the bottom. The beach ball and ping-pong ball floated very high. The whiffle ball floated high when the side with the holes was up. It still floated when the holes were down and the ball was filled with water, but all but the very top of the ball was under water.

I think, therefore, that the plastic that the ball was made out of weighs a little less than the water and that air weighs less than water. Glass is heavier than water and the clear plastic was also heavier. The rubber ball was very hard rubber and it was heavier than the water but not as heavy as the glass.

I tried my experiments with the bathtub full and half-full of water.

(d) Recipes for making balls.

Blow Recipes (soap bubbles, balloon skins, balloons).

Roll Recipes (clay, dough).

Dip Recipes (wax, "taffy apple" idea).

Mold Recipes (mold-like freezing water, Plaster of Paris).

(e) How we use balls in games.

to throw and catch

to throw and hit

to throw at a target

to roll at a target

to roll to collide with other balls

to roll down a shoot

to throw over a net

to throw into a net

to kick

to bounce

to shoot

to hit and roll

to float

to bat

Can you figure out what the names of the games are?

Please return to: "Teacher to Teacher" Editor
Learning Centers Project
Durham Child Development Center
16th and Lombard Streets
Philadelphia, Pa. 19146

QUESTIONNAIRE: FROM "MY BALL" TO "SPHERE"

1. Would you want to use this booklet in your classroom (or with the teachers with whom you work)? If not, could you explain why?

2. How would you use this booklet? (a) Give to teachers? (b) In combination with in-service training? (c) Pre-service training? (d) Reference library? (e) Other?

3. Do you now use booklets like this? If so, how would you compare the usefulness, attractiveness, and readability of this booklet to those now available to you?

4. Are there other subject areas you would like to see covered in similar materials? (We have other teacher-writings in process which might fit your needs.)

THANK YOU FOR YOUR ATTENTION TO THIS QUESTIONNAIRE.